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SPECIFICATIONS FOR MAKING AIRPLANE WEATHER OBSERVATIONS AT
FORT SMITH, MACKENZIE PROVINCE, CANADA,
Latitude 60°N, Longitude 112°W.

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U. S. Department of Agriculture

For making one airplane weather observation flight daily, Sundays and holidays included, for the Weather Bureau from May 1, to June 30, 1936, incl., in accordance with the following schedule and conditions:

For a daily flight started at one half hour before sunrise (local time) to 16,500 feet above sea-level. By "starting" a flight is meant the actual take-off of the airplane. By "ground" is meant the point over the airport corresponding to the elevation of the floor of the instrument shelter in which the aerometeorograph is placed before being mounted on the airplane. (Bidder must return these specifications with his bid. Another copy of the specifications will be furnished upon request, if desired.)

Cost per flight.....\$_____

I. SCHEDULE OF FLIGHTS-

- (a) Although flights must be started as a rule at the time specified above, latitude in starting them earlier or later will be allowed under conditions set forth hereinafter.
- (b) No flight shall be started earlier than one hour before sunrise (local time).
- (c) Flights started later than sunrise (local time) unless any of the conditions specified under par. VI(c) (8) of these specifications obtain, will be considered late.
- (d) Whenever a flight is delayed due to any of the conditions specified under par. VI(c) (8) of these specifications, it shall be started as soon as possible after the conditions of exemption specified under par. VI(c)(8) no longer obtain.

II. WEATHER CONDITIONS-

- (a) Weather conditions will be considered unfavorable for the making of flights when,
 - (1) the ceiling at the airport from which the flights are regularly made is reported by the Weather Bureau as being lower than 1,000 feet or,
 - (2) the visibility is reported by the Weather Bureau as being less than 2 miles.

III. DEFINITION OF FLIGHT-

- (a) A flight will consist of making an airplane ascent (the airplane to be instrumentally equipped as hereinafter set forth), at a rate of ascent not greater than 1,500 feet per any five-minute period. (Time intervals during which airplane is leveling off, as indicated in the following paragraph (b), will be deducted in computing above rate of ascent.)
- (b) The airplane must level off during the ascent for one minute at 1,500 feet above ground and at each successive 3,000-foot interval up to and including, the maximum elevation reached.
- (c) After reaching the maximum elevation the airplane will return to the ground as rapidly as practicable, proper caution being taken so that the rapid air speed will not cause the aerometeorograph to break loose from its mounting.
- (d) The place of landing must be at the place of take-off unless weather conditions as indicated under par. II of these specifications, make this impracticable.
- (e) The entire flight must be made, as nearly as practicable, directly over the airport from which the take-off is regularly made.
- (f) No ascent reaching a maximum height equal to less than 20% of the difference in elevation between the ground and 16,500 feet above sea-level, shall be deemed to constitute a flight within the meaning of these specifications.
- (g) The maximum height of each flight will be computed and determined from the aerometeorograph record by standard Weather Bureau methods. In the event of failure of the aerometeorograph to record, payment will be made on the basis of the altimeter readings as provided for under par. IV(d) of these specifications. Such altimeter readings will be corrected, if necessary, by the Weather Bureau, in accordance with the previous general agreement found between the altimeter indications and the height as computed by standard Weather Bureau methods.

IV. REPORT OF FLIGHT-

The pilot shall submit promptly after each landing, to the local Weather Bureau representative, a written and signed statement containing the following information: (All eleva-

tions, furnished by the pilot will be obtained from the altimeter.)

(a) Time and altimeter reading when,

- (1) Entering and emerging from clouds, fog, smoke, haze, and dust;
- (2) Encountering and emerging from precipitation;
- (3) Encountering and emerging from any other unusual condition;
- (4) The airplane entered or emerged from the base, top, or side of each cloud or other condition referred to;
- (5) Ice formed on the plane, including times of beginning and ending, thickness, and type of ice formation and the parts of the plane on which it formed. It is important to classify properly the type of ice deposit. These classifications will be designated as, (1) hard ice, (2) rime, (3) frost. Hard ice will be sub-divided as follows: (a) clear, (b) not clear. As complete a description of the appearance and structure of the formation as possible will be given. To aid in properly classifying the ice formation the following general descriptions are given:

HARD ICE. This is the same general type as that commonly known as glaze, which forms on the ground, trees, and other objects from rain when the temperature of these objects is below 0°C. It usually is clear and glassy in appearance but occasionally the formation is milky, i.e., translucent or opaque, due to the presence of air bubbles between the layers. This latter type should be classified under (1) hard ice (b) not clear, whereas, the former type should be classified under (1) hard ice (a) clear. Hard ice is generally smooth but it might be rough when mixed with snow or sleet or when freezing takes place slowly. Under the latter conditions, ridges are likely to form.

RIME. Rime consists of hard, whitish, opaque ice pellets, or grains, frequently intermixed with a frost formation of light feathery crystalline structure. Rime deposits on mountains have been described as snow-white, plug-like, truncated cones with the small end toward the surface upon which it is deposited. The plugs showed a fib-

rous structure and occasionally shiny surfaces. The particles from which the plugs were composed were firmly held together but the plugs themselves could easily be separated from one another. Their interior was usually of granular appearance. The spaces between the plugs were filled with a powder composed of these grains. Unlike hard ice, rime builds outward from the leading edges of the plane into a sharpnosed shape. As a rule it does not adhere to the plane as firmly as hard ice and is less resistant to the vibration and wind force encountered in flight.

FROST. This type of deposit is of light feathery crystalline structure such as is often observed on ground objects in the early morning. It is formed by sublimation, i.e., by condensation directly from the vapor to the solid state.

- (6) Entering and emerging from turbulent layers. Turbulence will be classified into four degrees of intensity. It is intended, however, that the pilot report turbulence only for the last three degrees. The first degree classification is included merely to assist in making comparisons. In cases when no record of turbulence is made by the pilot, it will be understood that the atmosphere is either free from turbulence, or that turbulence of slight intensity prevails.

TURBULENCE SCALE

Slight turbulence: The airplane rocks gently or there occur slight isolated bumps. No adjustments of control surfaces to overcome bumps are necessary. Revolutions per minute (R. P. M.) of the motor and the air speed remain constant.

Moderate turbulence: More frequent rocking (rolling) of the airplane about the longitudinal (fuselage) axis occurs. Rolling motion is moderate. Repeated slight adjustment of the ailerons necessary. R. P. M. of motor remain constant, Small fluctuations of the air speed occur.

Strong turbulence: Airplane goes off the course. Airplane rolls (rocks) from side to side. Strong vertical bumps felt. Continual operation of the ailerons, elevator, and rudder necessary. Those in the airplane feel themselves lifted from and pressed down into seats. Sensations felt like those experienced when riding in an elevator which is being accelerated or decelerated. Motor "revs"

up audibly. Distinct fluctuations in R. P. M.'s of propellor and in the air speed take place.

Severe turbulence: Dropping (pancaking) or lifting up of airplane occurs. Airplane tips repeatedly on its wing, ("drops off" on its wing). Airplane responds to the controls with difficulty. Those in the airplane are lifted from the seats (hang by their safety belts). Marked "revving" up of the motor (varying howling noises) observed. Pronounced change of the R. P. M.'s of the propellor and of the air speed.

- (b) Indication of the fact whenever the airplane does not emerge at the maximum altitude from one or more of the conditions referred to in (a) above.
- (c) Estimate of the elevation of any of the conditions referred to in (a) above, whenever such conditions prevail but are not actually entered by the airplane, and it is practicable to estimate their elevation with reasonable accuracy, such elevations always being marked, "Estimated, not entered".
- (d) Time of reaching, and altimeter reading at, maximum altitude.
- (e) Types of, and number of tenths of each type of cloud visible to pilot during the ascent, such entries to indicate the time observed. Whenever possible, the pilot should ascertain from the Weather Bureau observer, the direction from which the clouds are moving and enter this in his notes.
- (f) Time of occurrence of lightning and thunder, or both, and the direction from station observed or heard; also, whether nearby or distant.
- (g) Times should be indicated to nearest minute.
- (h) Elevations should be indicated to have been obtained from altimeter.
- (i) Indication as to whether altimeter readings are above ground or above sea level.
- (j) Altimeter setting at take-off.
- (k) Pilot will cause the electric time-recording pen to mark on the meteorogram at moment of take-off and beginning of descent and whenever conditions in (a) above, occur.

V. EQUIPMENT AND PERSONNEL-

(a) To be furnished by the Weather Bureau.

- (1) The Weather Bureau will furnish an aerometeorograph (weight approximately 7 lbs.) for recording temperature, pressure, and humidity.
- (2) A representative of the Weather Bureau will mount this instrument on the airplane before each flight is begun and remove it from the airplane when the flight is terminated.

(b) To be furnished by the contractor.

- (1) The contractor must furnish properly licensed pilot; airplane having service ceiling of 16,500 feet, i.e., capable of climbing 100 feet per minute at an elevation of 16,500 feet above sea level, with load including aerometeorograph, pilot, and sufficient fuel for three hours' flight.
- (2) The contractor must furnish a suitable mounting apparatus for carrying the above-mentioned aerometeorograph on the airplane, including wiring, battery, and connectors for operating the electric time-recording pen. This pen is operated by means of magnet coils wound to be used with either a 6- or 12-volt storage battery with an open circuit. However, two ordinary dry cells can be used, if preferred. No. 18 to 24 rubber covered wire or flexible cord is recommended for the connections. The aerometeorograph must be mounted as follows:
 - (i) On a biplane, between the wings as far from the fuselage as possible (not less than 6 feet), from $1/2$ to $2/3$ of the distance from the lower to the upper wing and from $1/2$ to $2/3$ of the distance back from the leading edge of the upper wing to the rear edge of the upper wing. If practicable, it will be preferable to mount it approximately even with the leading edge of the upper wing.
 - (ii) On a monoplane, as far from the fuselage as possible (not less than 6 feet), from $1/2$ to $2/3$ of the distance from the leading edge to the rear edge of the wing and as far below the wing as possible, but in no case will the distance below the wing be less than 18 inches.
 - (iii) The position and method of mounting the aerometeorograph must be approved by the Weather Bureau representative.

VI. PAYMENT-

- (a) Payment will be made as soon after the end of each month as it is possible to audit the vouchers at the U. S. Department of Agriculture, Washington, D. C.
- (b) No additional payment will be made for flights reaching higher than 16,500 feet above sea level, but for flights reaching less than 16,500 feet above sea level, payment will be made in accordance with the following percentage scale (computations will be carried to the nearest whole foot):

A percentage will be found by dividing the maximum height reached above ground by the difference in height between the ground and 16,500 feet above sea level:

(NOTE: In the following paragraphs "basic price" shall mean "the contract price of one daily flight to 16,500 feet above sea level made in accordance with these specifications".)

when this percentage is less than 100, but equal to 90 or more, a payment of 90% of basic price will be made;

when this percentage is less than 90, but equal to 80 or more, a payment of 80% of basic price will be made;

when this percentage is less than 80, but equal to 70 or more, a payment of 70% of basic price will be made;

when this percentage is less than 70, but equal to 60 or more, a payment of 60% of basic price will be made;

when this percentage is less than 60, but equal to 50 or more, a payment of 50% of basic price will be made;

when this percentage is less than 50, but equal to 40 or more, a payment of 40% of basic price will be made;

when this percentage is less than 40, but equal to 30 or more, a payment of 30% of basic price will be made;

when this percentage is less than 30, but equal to 20 or more, a payment of 20% of basic price will be made;

when this percentage is less than 20, no payment will be made for the flight.

- (c) While the contractor shall have the right or decision as to whether or not any flight shall be made,
 - (1) there will be deducted from amounts otherwise due him liquidated damages at the rate of 100% of basic price for each day's failure to make such flight, except

when the failure is due to any of the conditions specified under par. VI(c)(8) of these specifications.

- (2) When the flight is started later than sunrise (local time), but not later than 90 minutes after sunrise (local time) and the delay is due to conditions other than those specified under par. VI(c)(8) of these specifications, there will be deducted liquidated damages from the amount earned by the contractor for the flight made on that day as follows:
 - (i) if the amount earned is 20% of the basic price, the liquidated damages to be deducted therefrom will be 20% of the basic price, or
 - (ii) if the amount earned is 30% or more of the basic price, the liquidated damages to be deducted therefrom will be 25% of the basic price.
- (3) When the flight is started later than 90 minutes after sunrise (local time) and the delay is due to conditions other than those specified under par. VI(c)(8) of these specifications there will be deducted liquidated damages from the amount earned by the contractor for the flight made on that day as follows:
 - (i) if the amount earned is 50% or less of the basic price, the liquidated damages to be deducted therefrom will be made equal to the amount earned; or
 - (ii) if the amount earned is 60% or more of the basic price, the liquidated damages to be deducted therefrom will be 50% of the basic price.
- (4) Whenever, because any of the conditions specified under par. VI(c)(8) of these specifications prevail, a flight is not made until later than sunrise (local time) and a delay of more than 90 minutes, but not more than 3 hours, occurs before a flight is started after such conditions no longer obtain, as determined by the Weather Bureau representative, there will be deducted liquidated damages from the amount earned by the contractor for the flight made on that day as follows:
 - (i) if the amount earned is 20% of the basic price, the liquidated damages to be deducted therefrom will be 20% of the basic price; or
 - (ii) if the amount earned is 30% or more of the basic price, the liquidated damages to be deducted therefrom will be 25% of the basic price.

- (5) Whenever, because any of the conditions specified under par. VI(c)(8) of these specifications prevail, a flight is not made until later than sunrise (local time) and a delay of more than 3 hours occurs before a flight is started after such conditions no longer obtain, as determined by the Weather Bureau representative, there will be deducted liquidated damages from the amount earned by the contractor for the flight made on that day, as follows:
- (i) if the amount earned is 50% or less of the basic price, the liquidated damages to be deducted therefrom will be made equal to the amount earned; or
 - (ii) if the amount earned is 60% or more of the basic price, the liquidated damages to be deducted therefrom will be 50% of the basic price.
- (6) If, on any day, a flight reaching a maximum height equal to 20% or more, of the difference in elevation between the ground and 16,500 feet above sea level, but reaching less than 16,500 feet above sea level, is made at the scheduled time, i. e., between one hour before sunrise and sunrise (local time) or within the 90-minute time limit as specified in par VI(c)(4) of the specifications, the contractor shall have the option of making another flight on the same day, and in such cases, when another flight is made, he will be paid according to the maximum height reached in the later flight, provided this was higher than that reached in the first flight, and no deduction will then be made for the lateness of the flight.
- (7) Payment will not be made for more than one flight on any one day, nor for any flight started earlier than one hour before sunrise (local time) or later than one hour before sunset (local time) on any day.
- (8) No deductions in payment will be made from amounts otherwise due the contractor for failure to start a flight on scheduled time nor for failure to make a flight on any day when the cause is due to,
- (i) unfavorable weather conditions as specified under par. II of these specifications;
 - (ii) take-offs or landings being impracticable due to dangerous surface conditions in the opinion of the Weather Bureau representative;
 - (iii) sudden changes in weather conditions, e.g., extremely low temperatures or rapid thaws, requiring special treatment to start motor or changing to a different type of landing gear and is concurred in by the Weather Bureau representative. This exemption, however, will not apply for two or more consecutive days.

(iv) the Weather Bureau representative not being prepared to mount the aerometeorograph on the airplane.

(9) If failure to make a flight on any day is due to the Weather Bureau representative not being prepared to mount the aerometeorograph on the airplane, full payment of the basic price will be made.

VII. CONTRACT-

Each bidder must furnish a guarantee bond or certified check drawn in favor of the Disbursing Clerk, U. S. Department of Agriculture, as security in the amount of \$150.00 guaranteeing that he will not withdraw his bid within 30 days after the opening of same and that he will, if awarded the contract, execute formal contract and bond, such bond to be in amount of \$1800.00.

VIII. GENERAL-

- (a) The contractor for these flights will be required to comply with all rules and regulations of the Canadian Government regarding the airplane and equipment and the necessary pilot's license.
- (b) In view of the frequent hazardous conditions under which these flights are made, the carrying of free or pay passengers, except a properly licensed pilot or Weather Bureau official, on these flights is prohibited. The contractor will not be required to carry a Weather Bureau representative on these flights.
- (c) The contractor shall, without additional expense to the Weather Bureau, obtain all required licenses and permits. The United States Government shall not be responsible for any damages to persons and property that occur as a result of the fault or negligence of the contractor in connection with the prosecution of the work.
- (d) The flights shall be made at Fort Smith, Mackenzie Province, Canada. Lat. 60°N., Long. 112°W. Elevation of ground above sea level 650 feet.
- (e) If the contractor fails to attain a height of 16,500 feet above sea level on more than three days during any 30 consecutive days, except when in the judgment of the Weather Bureau Officials conditions make this excusable, or for any other reason fails to perform satisfactorily the airplane service required herein, the Weather Bureau may procure such service in the open market and the contractor and his sureties will be held liable to the Government for any excess cost over the contract rate occasioned the Government thereby.
- (f) The Weather Bureau reserves the right to reject any or all bids.

AWARD OF THIS PROPOSAL IS CONTINGENT UPON THE APPROVAL OF SPECIAL ALLOTMENT OF FUNDS TO THE WEATHER BUREAU FOR THE REMAINDER OF THE FISCAL YEAR ENDING JUNE 30, 1936.

REMARKS-

The office of the Civil Aviation Branch of the Department of National Defence at Ottawa, Canada, has provided the Weather Bureau with the following information in regard to facilities for flying at Fort Smith:

Landing Field. All flying in this district is carried out on floats in summer and skis in winter. A landing field usable in winter only has been prepared adjacent to Fort Smith so as to give better winter flying conditions than are obtainable by using the rough ice on the Slave River. The use of the seaplane base and winter base will be permissible.

Pilot's License. Any pilot flying regularly in Canada must take out a Canadian license. American citizenship is no bar to this and the qualifications are much the same as those in force in the United States.

Night Flying. There are no facilities north of Edmonton for night flying.

Hangar Space. There is no hangar space available at Fort Smith.

Airplane Service. Fort Smith is a busy base for aircraft and many of the leading companies are established there. There should be no difficulty in arranging for normal running repairs and service.

Gas and Oil. These may be had in quantity. It might be advisable to arrange with the Imperial Oil Company in advance for all requirements.

Ski Landing Equipment. This is essential for the winter season, lasting from approximately October 16th to June 1st.

Living Quarters. No difficulty is anticipated in arranging for these. There is a good inn at Fort Smith.

Food and Fuel. These should be readily available.

Office Space. Arrangements for this should not be difficult.

Population of Fort Smith. The total population as given by the North West Territories Branch, is 343, including Indians.

Telephone, Telegram and Radio. Only radio facilities are available.

Two-way Communication. Radio communication with the pilots in flight can be arranged with the Royal Canadian Corps of Signals Station at Fort Smith in code only at present on any frequency required but it is possible that telephone communication might be arranged later in the year.

Travelling Facilities. Fort Smith is easily accessible in the summer time by rail to Waterways and thence by plane from McMurray or by river steam boat.